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(54) **METHOD OF MANUFACTURING LIQUID EJECTING HEAD**

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B32B 37/18 (2006.01)
B41J 2/16 (2006.01)

(52) **U.S. Cl.**
CPC ***B32B 37/18*** (2013.01); ***B41J 2/161*** (2013.01); ***B41J 2/1623*** (2013.01)

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CPC H01L 41/083; Y10T 29/42; Y10T 29/49771; B32B 37/12; B32B 37/18
USPC 156/64, 350, 351, 378, 379
See application file for complete search history.

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(57) **ABSTRACT**

Disclosed is a method of manufacturing a liquid ejecting head where first and second members with different sizes which are formed of silicon are laminated with an adhesive agent. The method includes measuring a distance between a reference point which is positionally aligned in the laminating direction with respect to an imaging unit and a surface which extends from the bonding surface of the second member, and imaging the bonding surface by calculating a focal point distance of the imaging unit based on the distance which is measured and a distance between the imaging unit and the reference point.

10 Claims, 4 Drawing Sheets

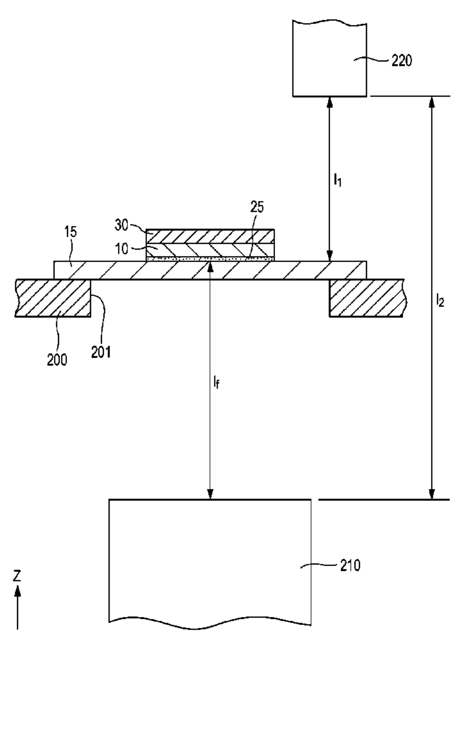

FIG. 1

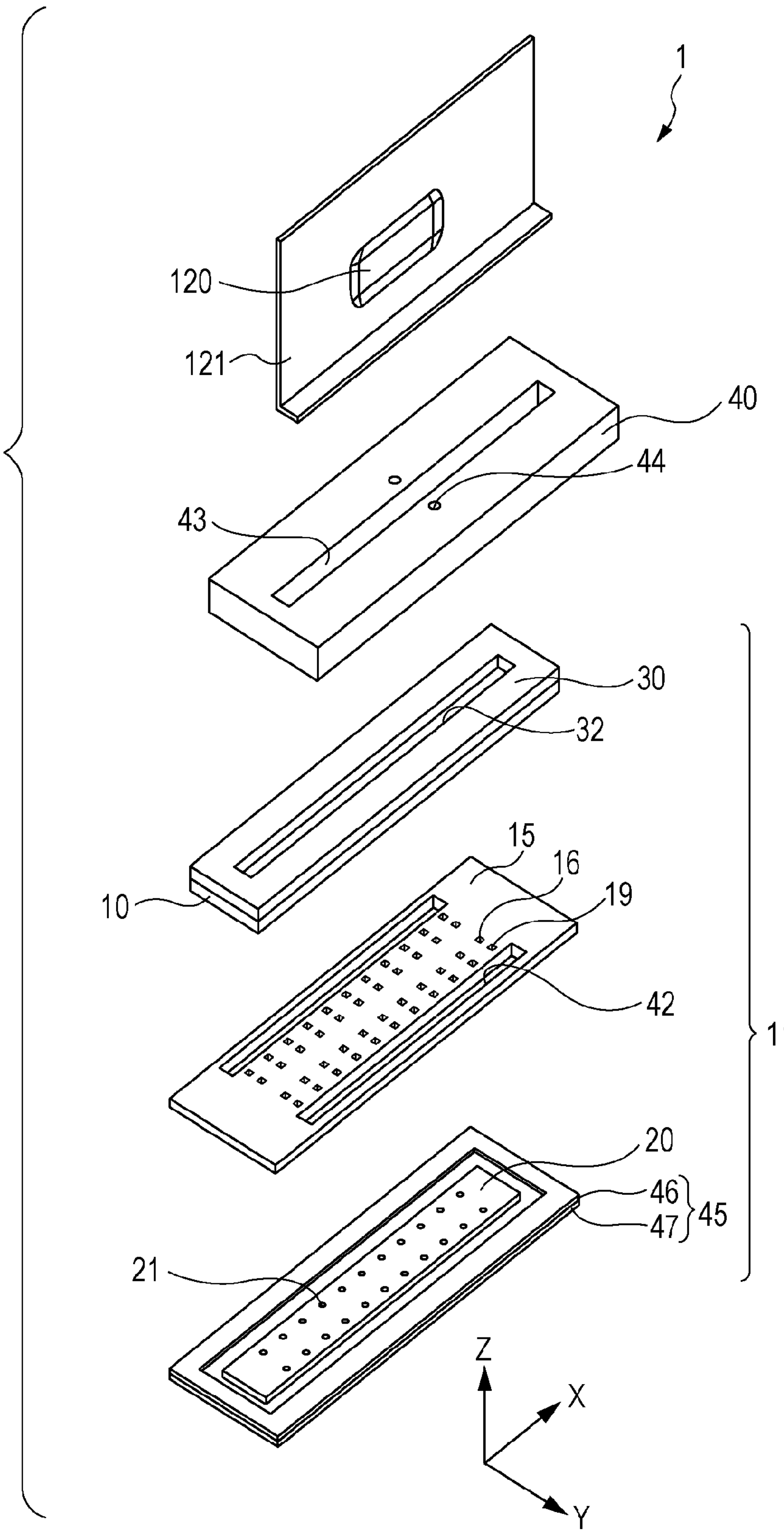

FIG. 2

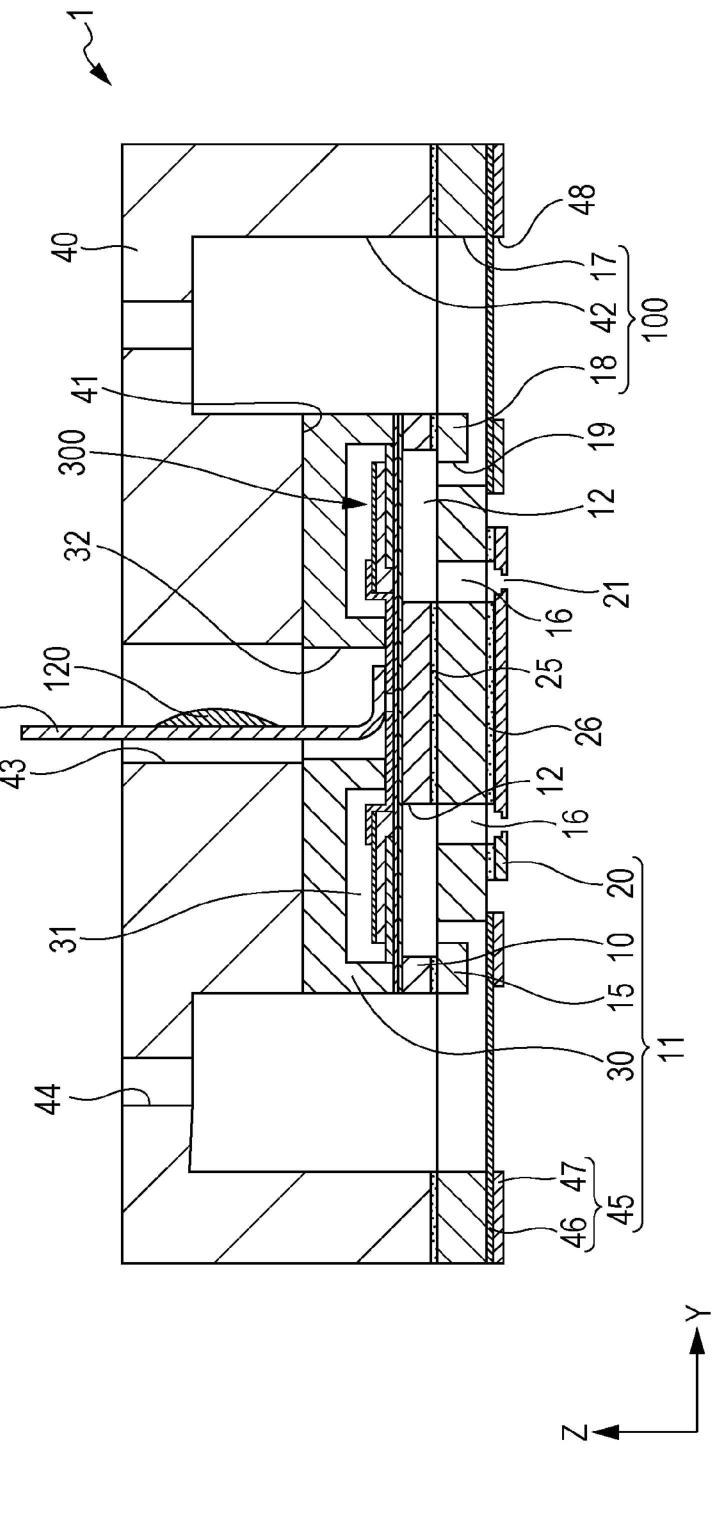
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FIG. 3

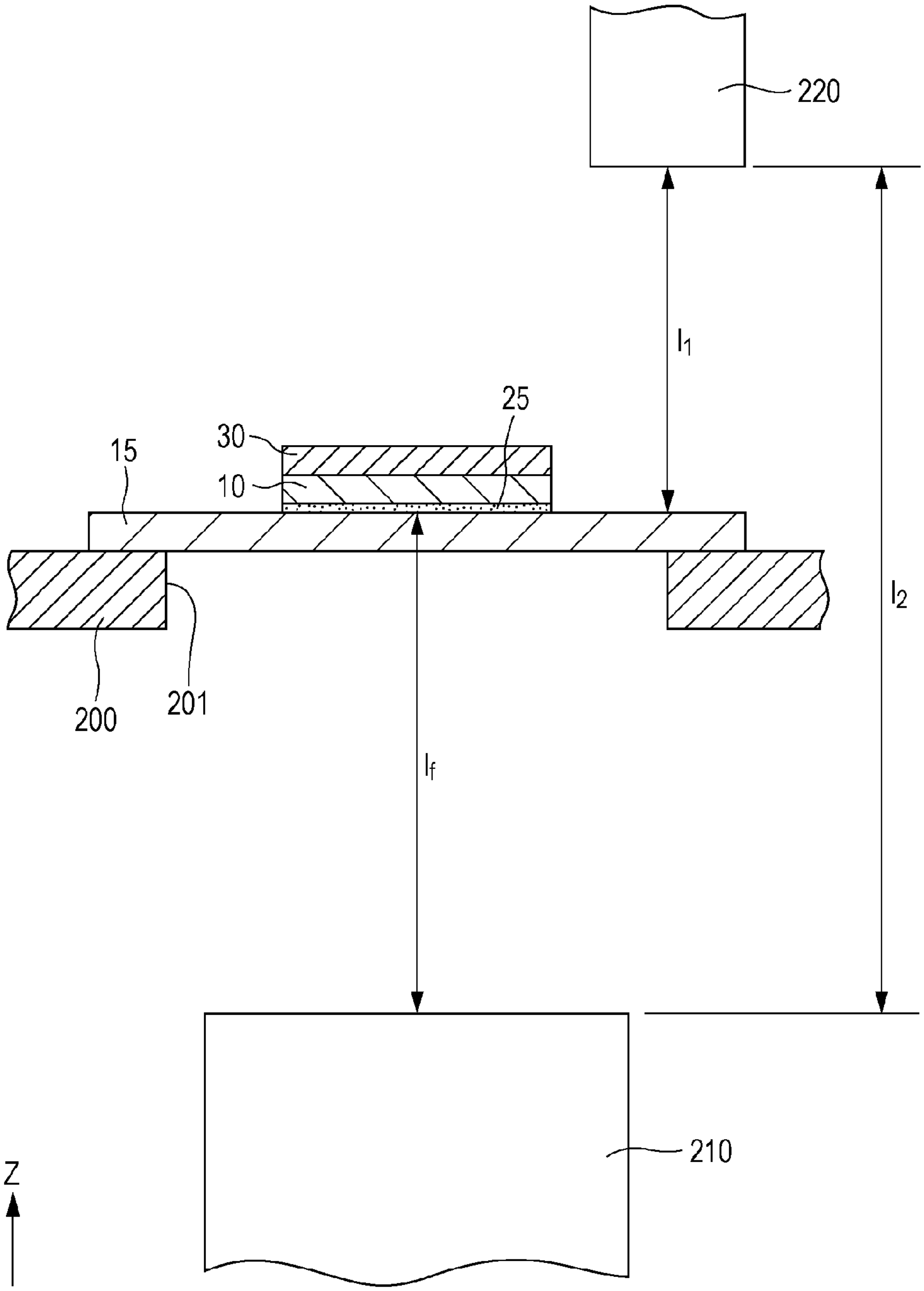
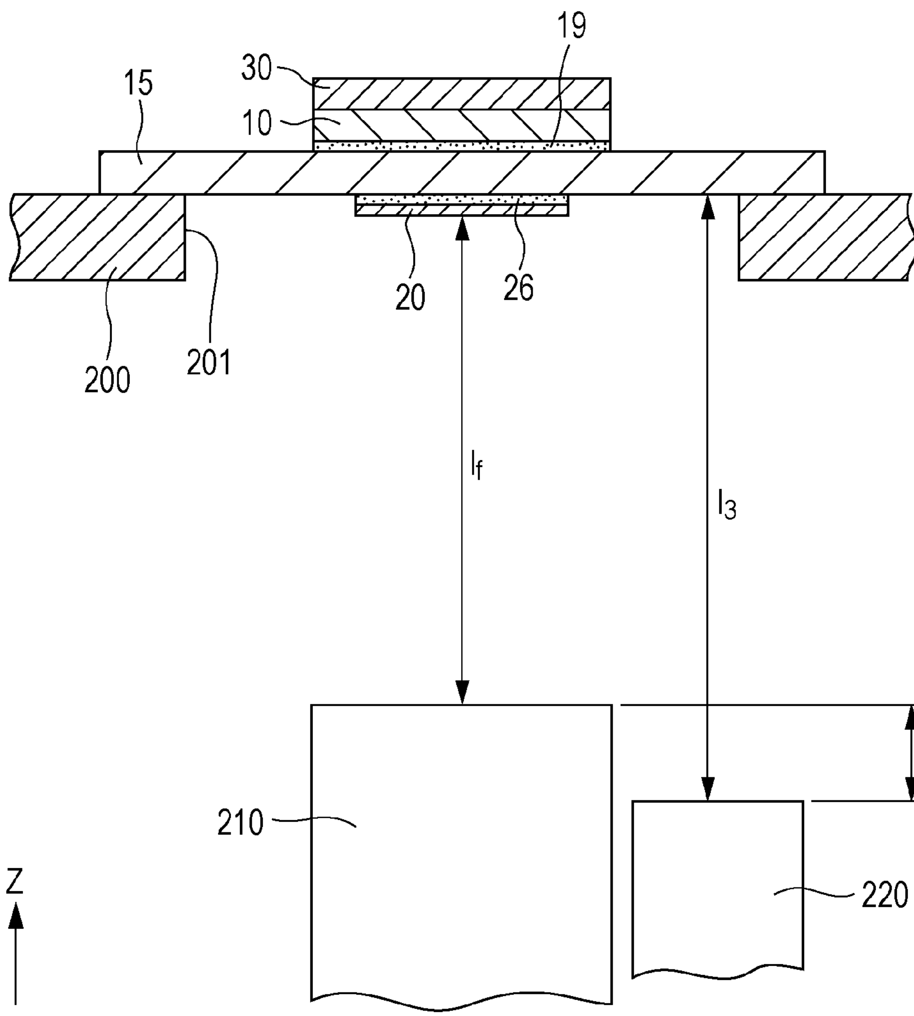


FIG. 4



METHOD OF MANUFACTURING LIQUID EJECTING HEAD

This application claims priority to Japanese Patent Application No. 2013-212636, filed Oct. 10, 2013, the entirety of which is expressly incorporated by reference herein.

BACKGROUND

1. Technical Field

The present invention relates to a method of manufacturing a liquid ejecting head which ejects a liquid from a nozzle opening, in particular, to a method of manufacturing an ink jet type recording head which discharges ink as the liquid.

2. Related Art

A liquid ejecting head has an ink jet type recording head which discharges ink droplets as a liquid. The ink jet type recording head is formed by laminating members formed of silicon in order to form a flow path with high density and high precision.

Here, when the members formed of silicon are laminated via an adhesive agent, it is necessary to confirm the bonding surfaces in a non-destructive manner. For this reason, there is proposed a manufacturing method where the bonding surfaces are confirmed in a non-destructive manner by confirming the bonding surfaces by transmitting infrared rays through the silicon members using an infrared microscope utilizing the property that infrared rays are transmitted through silicon (for example, refer to JP-A-2012-183792).

However, when trying to confirm the bonding surfaces with an infrared microscope, there is a problem that it is not possible to perform judgment of the adhesion state of the bonding surfaces with high precision since the focal point distance is not clear.

Here, this problem is not only with methods of manufacturing an ink jet type recording head, but also with methods of manufacturing a liquid ejecting head which ejects liquids other than ink in the same manner.

SUMMARY

An advantage of some aspects of the invention is to provide a method of manufacturing a liquid ejecting head which is able to perform judgment of an adhesion state with high precision.

According to an aspect of the invention, there is provided a method of manufacturing a liquid ejecting head in which members with different sizes which are formed of silicon are laminated with an adhesive agent and which ejects a liquid from a nozzle opening, the method including, in a state where a first member where a shape of a surface on a bonding surface side is relatively small and a second member where a shape of a surface on a bonding surface side is larger than the first member are adhered to each other using the adhesive agent, when the bonding surface is imaged by transmitting infrared rays through the first member or the second member using an imaging unit which performs imaging using infrared rays from one side in a laminating direction, measuring a distance between a reference point which is positionally aligned in the laminating direction with respect to the imaging unit and a surface which extends from the bonding surface of the second member, and imaging the bonding surface by calculating a focal point distance of the imaging unit based on the distance which is measured and a distance between the imaging unit and the reference point.

In this aspect, since it is possible to measure the focal point distance of the imaging unit with high precision, it is possible for the imaging unit to image an image with high precision based on the focal point distance. Accordingly, it is possible to confirm the state of the bonding surface with high precision and it is possible to suppress defects due to bonding failure.

In this case, the bonding surface may be imaged by transmitting infrared rays through the first member using the imaging unit and the bonding surface may be imaged by transmitting infrared rays through the second member using the imaging unit.

In this case, the reference point may be arranged on the imaging unit side in the laminating direction of the first member and the second member which are laminated and the reference point may also be arranged on the opposite side to the imaging unit in the laminating direction of the first member and the second member which are laminated.

In this case, it is preferable that the measuring of the distance between the reference point and the surface which extends from a bonding surface of the second member be performed using a non-contact type measuring unit. Due to this, it is possible to suppress the generation of scratches or chipping due to contact with the second member.

In this case, it is preferable that the measuring unit be a laser type range finder. Due to this, it is possible to measure the focal point distance with higher precision.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be described with reference to the accompanying drawings, wherein like numbers reference like elements.

FIG. **1** is an exploded perspective diagram of a recording head according to Embodiment 1 of the invention.

FIG. **2** is a cross sectional diagram of the recording head according to Embodiment 1 of the invention.

FIG. **3** is a cross sectional diagram which shows a method of manufacturing the recording head according to Embodiment 1 of the invention.

FIG. **4** is a cross sectional diagram which shows a method of manufacturing the recording head according to Embodiment 1 of the invention.

DESCRIPTION OF EXEMPLARY EMBODIMENTS

Below, detailed description will be given of the invention based on an embodiment.

Embodiment 1

FIG. **1** is an exploded perspective diagram of an ink jet type recording head which is an example of a liquid ejecting head according to Embodiment 1 of the invention and FIG. **2** is a cross sectional diagram of the ink jet type recording head.

As shown in the diagram, the ink jet type recording head **1** of the present embodiment is provided with a plurality of members such as a head body **11** and a case member **40** and the plurality of members are bonded by an adhesive agent or the like. In the present embodiment, the head body **11** is equipped with a flow path forming substrate **10**, a communication board **15**, a nozzle plate **20**, a protection substrate **30**, and a compliance substrate **45**.

The flow path forming substrate **10** which configures the head body **11** is formed of a silicon monocrystal substrate. Pressure generating chambers **12**, which are partitioned by a plurality of partition walls, are lined up through anisotropic etching from one surface side in the flow path forming substrate **10** along a direction in which a plurality of nozzle openings **21** which discharge ink are lined up. Below, this direction is referred to as the lining up direction of the pressure generating chambers **12** or as a first direction X. In addition, a plurality of rows, two rows in the present embodiment, where the pressure generating chambers **12** are lined up in the first direction X are provided in the flow path forming substrate **10**. A row alignment direction, which is the alignment direction of a plurality of rows of the pressure generating chambers **12** in which the pressure generating chambers **12** are formed along the first direction X, is referred to below as a second direction Y. Furthermore, a direction in which the flow path forming substrate **10**, the communication board **15**, the nozzle plate **20**, and the protection substrate **30** are laminated is referred to below as a third direction Z.

In addition, a supply path or the like which adds flow path resistance of ink which flows into the pressure generating chambers **12** and where the opening area is narrower than the pressure generating chambers **12** may be provided on one end section side of the pressure generating chambers **12** in the second direction Y in the flow path forming substrate **10**.

In addition, the communication board **15** is bonded with one surface side of the flow path forming substrate **10**. In addition, the nozzle plate **20** where a plurality of nozzle openings **21** which communicate with each of the pressure generating chambers **12** are drilled is bonded with the communication board **15**.

A nozzle communication path **16** which passes through the pressure generating chambers **12** and the nozzle openings **21** is provided in the communication board **15**. The communication board **15** has a larger area than the flow path forming substrate **10** and the nozzle plate **20** has a smaller area than the flow path forming substrate **10**. In this manner, it is possible to achieve a reduction in costs by making the area of the nozzle plate **20** comparatively small.

In addition, a first manifold section **17** and a second manifold section **18** which configure parts of a manifold **100** are provided in the communication board **15**.

The first manifold section **17** is provided to pass through the communication board **15** in the thickness direction (the laminating direction of the communication board **15** and the flow path forming substrate **10**).

In addition, the second manifold section **18** is provided to open on the nozzle plate **20** side of the communication board **15** without passing through the communication board **15** in the thickness direction.

Furthermore, a supply communication path **19** which communicates with one end section of the pressure generating chambers **12** in the second direction Y is independently provided for each of the pressure generating chambers **12** in the communication board **15**. The supply communication path **19** passes through the second manifold section **18** and the pressure generating chambers **12**.

In this manner, the communication board **15** is formed of a silicon monocrystal substrate. It is possible to suppress the generation of warping due to heating or cooling by using materials where the coefficient of linear expansion is equal to that of the flow path forming substrate **10** as the communication board **15**. In addition, it is possible to form a high density flow path easily and with high precision by using the silicon monocrystal substrate for the flow path forming substrate **10** or the communication board **15**.

In addition, in the present embodiment, the flow path forming substrate **10** and the communication board **15** are adhered via an adhesive agent **25**.

In addition, the nozzle openings **21** which communicate with each of the pressure generating chambers **12** via the nozzle communication path **16** are formed in the nozzle plate **20**. That is, the nozzle openings **21** which eject the same type of liquid (ink) are lined up in the first direction X and two rows of the nozzle openings **21** which are lined up in the first direction X are formed in the second direction Y.

It is possible to use a metal such as stainless steel (SUS), an organic material such as polyimide resin, a silicon monocrystal substrate, or the like as the nozzle plate **20**. Here, it is possible to suppress the generation of warping due to heating or cooling, cracking due to heat, detaching, or the like by setting the linear expansion coefficients of the nozzle plate **20** and the communication board **15** to be equal by using a silicon monocrystal substrate as the nozzle plate **20**. In addition, details will be described later; however, by using a silicon monocrystal substrate as the nozzle plate **20**, it is possible to perform confirmation of a bonding surface in the present embodiment by transmitting infrared rays through the nozzle plate **20** and imaging the bonding surface of the nozzle plate **20** and the communication board **15** using an imaging unit which performs imaging using infrared rays.

In addition, in the present embodiment, the communication board **15** and the nozzle plate **20** are adhered via an adhesive agent **26**.

On the other hand, a diaphragm is formed on the opposite surface side to the communication board **15** of the flow path forming substrate **10**. In addition, a piezoelectric actuator **300** which is a pressure generating unit of the present embodiment is configured by sequentially laminating a first electrode, a piezoelectric body layer, and a second electrode on the diaphragm. In general, the piezoelectric actuator **300** is configured by setting either one of the electrodes of the piezoelectric actuator **300** as a common electrode and patterning the other electrode and the piezoelectric body layer for each of the pressure generating chambers **12**.

In addition, the protection substrate **30** which has substantially the same size as the flow path forming substrate **10** is bonded with the surface on the piezoelectric actuator **300** side of the flow path forming substrate **10**. The protection substrate **30** has a holding section **31** which is a space for protecting the piezoelectric actuator **300**. In addition, a through hole **32** is provided to pass through the protection substrate **30** in the thickness direction (the laminating direction of the flow path forming substrate **10** and the protection substrate **30**). The end section of a lead electrode which is drawn out from the second electrode is provided to extend so as to be exposed inside the through hole **32** and the lead electrode is electrically connected inside the through hole **32** with a wiring substrate **121** which is mounted with a driving circuit **120** such as a driving IC.

It is possible to suppress the generation of warping due to heating or cooling, cracking due to heat, detaching, or the like by setting the linear expansion coefficients of the protection substrate **30** and the flow path forming substrate **10** to be equal by using a silicon monocrystal substrate as the protection substrate **30**. In addition, in the present embodiment, a bonded body where the flow path forming substrate **10** and the protection substrate **30** are bonded is referred to as an actuator unit.

In addition, the case member **40** which defines the manifold **100** which communicates with a plurality of the pressure generating chambers **12** and the head body **11** is fixed in the head body **11** with such a configuration. The case member **40** has substantially the same shape as the communication board **15** described above in a planar view and is bonded with the protection substrate **30** along with also being bonded with the communication board **15** described above. Specifically, the case member **40** has a concave section **41** with a depth where the flow path forming substrate **10** and the protection substrate **30** are accommodated on the protection substrate **30** side. The concave section **41** has a larger opening area than the surface which is bonded with the flow path forming substrate **10** of the protection substrate **30**. Then, the opening surface on the nozzle plate **20** side of the concave section **41** is sealed by the communication board **15** in a state where the flow path forming substrate **10** or the like is accommodated in the concave section **41**. Due to this, a third manifold section **42** is defined by the case member **40** and the head body **11** in an outer peripheral section of the flow path forming substrate **10**. Then, the manifold **100** of the present embodiment is configured of the first manifold section **17** and the second manifold section **18** which are provided on the communication board **15** and the third manifold section **42** which is defined by the case member **40** and the head body **11**.

Here, it is possible to use, for example, a resin, a metal, or the like as the material of the case member **40**. Here, it is possible to carry out mass production at a low cost by forming the case member **40** of resin material.

In addition, the compliance substrate **45** is provided on the surface where the first manifold section **17** and the second manifold section **18** of the communication board **15** are opened. The compliance substrate **45** seals the openings of the first manifold section **17** and the second manifold section **18**.

The compliance substrate **45** is equipped with a sealing film **46** and a fixing substrate **47** in the present embodiment. The sealing film **46** is formed of a thin film which has flexibility (for example, a thin film with a thickness of 20 μm or less which is formed of polyphenylene sulfide (PPS), stainless steel (SUS), or the like) and the fixing substrate **47** is formed of a hard material such as a metal such as stainless steel (SUS). Since the region which faces the manifold **100** of the fixing substrate **47** is an opening section **48** which is completely removed in the thickness direction, one surface of the manifold **100** is a compliance section which is a flexible section sealed only by the sealing film **46** which has flexibility.

Here, an introduction path **44** for supplying ink to each of the manifolds **100** by communicating with the manifolds **100** is provided in the case member **40**. In addition, a connection port **43** where a wiring substrate **121** is inserted by communicating with the through hole **32** of the protection substrate **30** is provided in the case member **40**.

When ink is ejected in the ink jet type recording head **1** with such a configuration, the ink is taken in from a retention unit such as an ink cartridge via the introduction path **44** and an inner section of the flow path is filled with ink from the manifold **100** up to the nozzle opening **21**. After that, by applying a voltage to each of the piezoelectric actuators **300** which correspond to the pressure generating chambers **12** in accordance with the signal from the driving circuit **120**, the piezoelectric actuator **300** and the diaphragm are bent and change shape. Due to this, the pressure inside the pressure generating chambers **12** is increased and ink droplets are ejected from a predetermined nozzle opening **21**. Here, from the connection port **43** up to the nozzle opening **21** in the ink jet type recording head **1** of the present embodiment is referred to as a liquid flow path. That is, the liquid flow path is configured of the connection port **43**, the manifold **100**, the supply communication path **19**, the pressure generating chambers **12**, the nozzle communication path **16**, and the nozzle opening **21**.

Here, description will be given of a method of manufacturing the ink jet type recording head **1** of the present embodiment with reference to FIG. **3** and FIG. **4**. Here, FIG. **3** and FIG. **4** are cross sectional diagrams which show a method of manufacturing the ink jet type recording head which is an example of a liquid ejecting head according to Embodiment 1 of the invention.

Firstly, in the present embodiment, by setting the flow path forming substrate **10** as a first member and the communication board **15** where the bonding surface side with the first member has a larger area than the first member as a second member, the adhesion state is confirmed by imaging the bonding surface when the first member and the second member are adhered via the adhesive agent **25**.

The piezoelectric actuator **300**, the pressure generating chambers **12**, and the like are formed in advance in the flow path forming substrate **10** of the present embodiment and additionally, the protection substrate **30** is bonded with the flow path forming substrate **10**. In addition, the nozzle communication path **16**, the first manifold section **17**, the second manifold section **18**, and the like are formed in advance on the communication board **15**.

After the flow path forming substrate **10** and the communication board **15** are adhered using the adhesive agent **25**, the bonding surface of the flow path forming substrate **10** and the communication board **15** is imaged using an imaging unit which performs imaging using infrared rays. That is, since silicon has a property of transmitting infrared rays, the bonding surface of the flow path forming substrate **10** and the communication board **15** is imaged using infrared rays which are transmitted through the flow path forming substrate **10** or the communication board **15** which is formed of silicon. In addition, the protection substrate **30** is bonded with the flow path forming substrate **10** in the present embodiment; however, since the protection substrate **30** of the present embodiment is formed of silicon, the protection substrate **30** also transmits infrared rays. However, in a case where the flow path forming substrate **10** and the protection substrate **30** are bonded using an adhesive agent or the like, since the adhesive agent reflects the infrared rays, it is not possible to image the region which overlaps the bonding region of the flow path forming substrate **10** and the protection substrate **30**. In addition, in a case where there is a layer of a metal or the like which does not transmit infrared rays between the flow path forming substrate **10** and the protection substrate **30**, it is also not possible to image the overlapped region in the same manner.

An apparatus which images a bonding surface of the flow path forming substrate **10** and the communication board **15** has a base **200** as shown in FIG. **3**.

The base **200** holds the bonded body of the flow path forming substrate **10** and the communication board **15** on one surface and has an opening section **201** which passes through the base **200** in the thickness direction. The opening section **201** is formed with an opening area which is smaller than the communication board **15** and larger than the flow path forming substrate **10**. In the present embodiment, the communication board **15** side of the bonded body is held on one surface of the base **200**.

An imaging unit **210** of the present embodiment is arranged on the other surface side of the base **200**. That is, in the present embodiment, the imaging unit **210** is arranged on the other surface side which is the opposite side to the one surface of the base **200** which holds the bonded body. Here, the imaging unit **210** operates by irradiating infrared rays to a target via an irradiating optical system and condensing light of the infrared rays which are reflected by the target with an object optical system. Examples of the imaging unit **210** which performs imaging using infrared rays include an infrared microscope or an infrared camera. An infrared camera is used as the imaging unit **210** in the present embodiment.

By arranging the imaging unit **210** on the other surface side of the base **200** in a state where the bonded body is held on one surface side of the base **200** by setting the communication board on the base **200** side, it is possible for the imaging unit **210** to image the bonding surface of the communication board **15** and the flow path forming substrate **10** by transmitting infrared rays through the communication board **15**.

In addition, a measuring unit **220** is provided on one surface side of the base **200**. The measuring unit **220** is provided at a position which faces a surface which extends from the bonding surface of the communication board **15** and the flow path forming substrate **10**, that is, the region which is not covered by the flow path forming substrate **10** in the bonding surface of the communication board **15** in the third direction Z.

Here, the measuring unit **220** measures a distance l_1 between a reference point which is positionally aligned in the third direction Z with respect to the imaging unit **210** and a surface which extends from the bonding surface of the communication board **15**.

That is, it is not possible for the measuring unit **220** to directly measure the bonding surface of the communication board **15** and the flow path forming substrate **10** and the reference point; however, since the side of the bonding surface of the communication board **15** and the flow path forming substrate **10** has a larger area than that of the flow path forming substrate **10**, a distance from the reference point to the bonding surface of the communication board **15** and the flow path forming substrate **10** is measured by measuring the distance l_1 between the surface, which extends from the bonding surface which is at the same position as the bonding surface bonded with the flow path forming substrate **10** of the communication board **15** in the third direction Z, and the reference point.

Examples of the measuring unit **220** include a non-contact type range finder (a distance measuring device) such as an optical type, an ultrasonic type, or a laser type, a contact type range finder (a distance measuring device) such as a Vernier micrometer, or the like. Here, in a case where a contact type range finder is used as the measuring unit **220**, since there is a concern that scratches, chipping, or the like will be generated in the communication board **15** due to the measuring unit **220** coming into contact with the communication board **15**, it is preferable to use a non-contact type range finder as the measuring unit **220** and it is particularly favorable to use a laser type range finder (a laser distance measuring device) with high precision.

In the present embodiment, the distance l_1 between the reference point and the surface which extends from the bonding surface of the communication board **15** is measured by setting a position which is a measuring reference of the measuring unit **220** as the reference point. Here, the reference point of the measuring unit **220** in the third direction Z is positionally aligned in the third direction Z with respect to the imaging unit **210** as described above. The distance between the reference point of the measuring unit **220** and the imaging unit **210** is set as l_2.

Then, the focal point distance l_f of the imaging unit **210** is calculated based on the distance l_1 from the reference point to the surface which extends from the bonding surface of the communication board **15** and the distance l_2 between the reference point of the measuring unit **220** and the imaging unit **210**, which are measured by the measuring unit **220**. That is, in the present embodiment, it is possible for the focal point distance l_f of the imaging unit **210** to be calculated using the expression $l_f = l_2 - l_1$.

Then, based on the focal point distance l_f, the imaging unit **210** images the bonding surface of the communication board **15** and the flow path forming substrate **10**. Here, based on the calculated focal point distance l_f, the focal point may be matched by adjusting the object optical system of the imaging unit **210** or the focal point may be matched by moving the imaging unit **210** in the third direction Z.

Since the focal point distance l_f of the imaging unit **210** is accurately measured, it is possible to set the image which is imaged in this manner as a high precision image. Then, it is possible to confirm the state of the bonding surface of the flow path forming substrate **10** and the communication board **15** from the image which is imaged in this manner. That is, infrared rays are reflected in the region where the adhesive agent **25** is present and infrared rays are transmitted in the region where an adhesive agent is not present. A bonding surface is represented in the image which is imaged according to the presence or absence of the reflection of infrared rays. Then, it is possible to confirm a bonding failure and to determine whether a product passes or fails by confirming the state of the bonding surface from the image which is imaged.

As described above, it is possible to measure the focal point distance l_f between the imaging unit **210** and the bonding surface of the communication board **15** which is a target and the flow path forming substrate **10** with high precision by using the surface which extends from the bonding surface of the communication board **15** which is the second member where the area on the bonding surface side is large. Accordingly, it is possible for the image where the bonding surface is imaged to be highly precise and it is possible to judge the state of the bonding surface with high precision without imaging the bonding surface using the imaging unit **210** in a state where the focal point does not match. In other words, it is possible to confirm the bonding state of the flow path forming substrate **10** and the communication board **15** based on the image which is imaged using the imaging unit **210**. Here, the pressure generating chambers **12** are formed with high density in the flow path forming substrate **10** and when an adhesion failure occurs between the image walls which define the pressure generating chambers **12** and the communication board **15** at the time of being adhered to the communication board **15**, defects occur such as not being able to discharge ink droplets normally. In the present embodiment, since it is possible to judge adhesion failures with high precision, it is possible to suppress the generation of defects such as discharge failures or the like.

Here, it is possible to use the method of imaging a bonding surface of two members which are formed of silicon by measuring a focal point distance using the imaging unit **210** and the measuring unit **220** in the same manner for other members which configure the ink jet type recording head **1**.

For example, in a case where the nozzle plate **20** in the ink jet type recording head **1** of the present embodiment is formed of silicon, a bonding surface where the first member (the nozzle plate **20**) and the second member (the communication board **15**) are bonded using the adhesive agent **26** may be imaged using the imaging unit **210** after setting the nozzle plate **20** as the first member and setting the communication board **15** where the side of the bonding surface with the first member has a larger area than that of the first member as a second member.

Here, it is possible to image the bonding surface of the nozzle plate **20** and the communication board **15** using the apparatus shown in FIG. **4** which is the same apparatus as in FIG. **3**. Here, the same numerals are applied to the same members as in FIG. **3** and repeated description thereof will be omitted.

As shown in FIG. **4**, a bonded body where the communication board **15** where the flow path forming substrate **10** or the like is bonded and the nozzle plate **20** are adhered via the adhesive agent **26** is held on one surface of the base **200**. At this time, the bonded body is held so as to arrange the nozzle plate **20** on the base **200** side.

The imaging unit **210** is arranged on the other surface side of the base **200**. In addition, the measuring unit **220** is arranged on the other surface side of the base **200**.

The measuring unit **220** measures a distance l_3 between the reference point and the surface which extends from the bonding surface of the communication board **15** and the nozzle plate **20**, that is, the surface which is at the same position as the nozzle plate **20** of the communication board **15** in the third direction Z.

In addition, the reference point of the measuring unit **220** is positionally aligned in the third direction Z with respect to the imaging unit **210** and when a distance between the reference point of the measuring unit **220** and the position which is a reference of the focal point distance of the imaging unit **210** is set as l_4, it is possible for the focal point distance l_f of the imaging unit **210** to be calculated based on the distance l_3 which is measured by the measuring unit **220** and the distance l_4 between the reference point and the imaging unit **210**. Here, as shown in FIG. **4**, in a case where the measuring unit **220** is arranged at the position which is separated to be further from the communication board **15** than from the imaging unit **210**, it is possible for the focal point distance l_f to be calculated with the expression $l_f=l_3-l_4$. In addition, in a case where the measuring unit **220** is arranged on the side closer to the communication board **15** than to the imaging unit **210**, it is possible for the focal point distance l_f to be calculated with the expression $l_f=l_3+l_4$.

In this manner, it is possible to measure the focal point distance l_f between the imaging unit **210** and the bonding surface which is imaged with high precision by measuring using the surface which extends from the bonding surface of the communication board **15** which is the second member where the area on the bonding surface side is large. Accordingly, it is possible to judge the state of the bonding surface of the nozzle plate **20** and the communication board **15** with high precision by imaging the bonding surface with high precision using the imaging unit **210** in a state where the focal points match without imaging the bonding surface using the imaging unit **210** in a state where the focal points do not match.

Here, since the base **200** and the imaging unit **210** have the same arrangement as in FIG. **3** described above, it is possible to use both the imaging unit **210** which images the bonding surface of the communication board **15** and the flow path forming substrate **10** and the imaging unit **210** which images the bonding surface of the communication board **15** and the nozzle plate **20** together as one. Due to this, it is not necessary to use two of the imaging unit **210**, which are expensive, and it is possible to reduce costs.

In addition, in the example shown in FIG. **4**, since the imaging unit **210** and the measuring unit **220** are arranged on the same surface side with respect to the base **200** (the imaging target), the measuring unit **220** may measure the distance between the base point of the focal point distance of the imaging unit **210** as a reference point and the surface which extends from the bonding surface of the communication board **15**. Due to this, it is possible to set the measuring result of the measuring unit **220** as the focal point distance of the imaging unit **210** as it is. Accordingly, it is not necessary to calculate the focal point distance and it is possible to measure the focal point distance easily and in a short time.

In addition, for the image of the bonding surface which is imaged by the imaging unit **210**, it is possible to automate imaging of the bonding surface and determination of whether the bonding state passes or fails, for example, by performing passing or failing determination according to the imaging process. In addition, since it is possible to automate the determination of whether the bonding state passes or fails, for example, it is possible to automate assembly of each of the members and automatically perform (unmanned) confirmation of the bonding state of the automatic assembly. Accordingly, it is possible to easily automate from the assembly to inspection. Naturally, an inspector may perform the confirmation of the bonding state from the image where the bonding surface is imaged.

Other Embodiments

Above, description is given of one embodiment of the invention; however, the basic configuration of the invention is not limited to the embodiment described above.

For example, in Embodiment 1 described above, description is given where the flow path forming substrate **10** or the nozzle plate **20** is the first member and the communication board **15** is the second member; however, in a case where the ink jet type recording head **1** has another member which is formed of silicon, the member may be equivalent to the first member or the second member. That is, the first member and the second member of the invention are not particularly limited as long as the members are members with different sizes which are formed of silicon and are adhered with an adhesive agent.

In addition, in Embodiment 1 described above, the imaging unit **210** which images the bonding surface of the flow path forming substrate **10** and the communication board **15** and the imaging unit **210** which images the bonding surface of the communication board **15** and the nozzle plate **20** are used together as one imaging unit **210**; however, the invention is not particularly limited to this, and for example, the imaging unit **210** may be respectively provided on both sides to interpose the base. Due to this, it is possible to image the bonding surface of the nozzle plate **20** and the communication board **15** with an arrangement such that the nozzle plate **20** side is the opposite side to the base.

In addition, in Embodiment 1 described above, the bonding surface of the flow path forming substrate **10** and the communication board **15** is imaged by transmitting infrared rays through the communication board **15**; however, the invention is not particularly limited to this, and the imaging of the bonding surface may be performed by transmitting infrared rays through the flow path forming substrate **10** which is the first member. Here, in a case where the protection substrate **30** is bonded with the flow path forming substrate **10** in advance as in Embodiment 1 described above, it is necessary to transmit infrared rays through the protection substrate **30** and the flow path forming substrate **10**; however, since the infrared rays which are transmitted through the protection substrate **30** are reflected in the adhesion region where the flow path forming substrate **10** and the protection substrate **30** are adhered, it is not possible to image the portion which overlaps the adhesion region of the flow path forming substrate **10** and the protection substrate **30**.

In addition, in Embodiment 1 described above, the bonding surface of the communication board **15** and the nozzle plate **20** is imaged by transmitting infrared rays through the nozzle plate **20**, but the invention is not particularly limited to this and the bonding surface may be imaged by transmitting infrared rays through the communication board **15**.

Furthermore, in Embodiment 1 described above, description is given where the thin film type piezoelectric actuator **300** is used as a pressure generating unit which generates pressure changes in the pressure generating chambers **12**, but the invention is not particularly limited to this, and for example, it is possible to use a thick film type piezoelectric actuator which is formed by a method such as sticking a green sheet, a longitudinal vibration type piezoelectric actuator which alternately laminates a piezoelectric material and an electrode forming material and expands and contracts these materials in a shaft direction, or the like. In addition, as the pressure generating unit, it is possible to use unit which discharges liquid droplets from a nozzle opening using bubbles which are generated by heating heater elements by arranging the heater elements inside pressure generating chambers, a so called electrostatic type actuator which discharges liquid droplets from a nozzle opening by changing the shape of a diaphragm using static electricity by generating static electricity between the diaphragm and an electrode, or the like.

Furthermore, the invention widely targets all liquid ejecting heads and it is also possible to apply the invention to, for example, a recording head such as various types of ink jet type recording head which are used in image recording apparatuses such as printers, a color material ejecting head which is used for manufacturing color filters such as a liquid crystal display, an electrode material ejecting head which is used for electrode forming such as organic EL displays and field emission displays (FED), a bio-organic matter ejecting head which is used for manufacturing bio chips, and the like.

What is claimed is:

1. A method of manufacturing a liquid ejecting head in which members with different sizes which are formed of silicon are laminated with an adhesive agent and which ejects a liquid from a nozzle opening, the method comprising:

in a state where a first member where a shape of a surface on a bonding surface side is relatively small and a second member where a shape of a surface on a bonding surface side is larger than the first member are adhered to each other using the adhesive agent,

when the bonding surface is imaged by transmitting infrared rays through the first member or the second member using an imaging unit which performs imaging using infrared rays from one side in a laminating direction,

measuring a distance between a reference point which is positionally aligned in the laminating direction with respect to the imaging unit and a surface which extends from the bonding surface of the second member; and

imaging the bonding surface by calculating a focal point distance of the imaging unit based on the distance which is measured and a distance between the imaging unit and the reference point.

2. The method of manufacturing a liquid ejecting head according to claim **1**,

wherein the bonding surface is imaged by transmitting infrared rays through the first member using the imaging unit.

3. The method of manufacturing a liquid ejecting head according to claim **1**,

wherein the bonding surface is imaged by transmitting infrared rays through the second member using the imaging unit.

4. The method of manufacturing a liquid ejecting head according to claim **1**,

wherein the reference point is arranged on the imaging unit side in the laminating direction of the first member and the second member which are laminated.

5. The method of manufacturing a liquid ejecting head according to claim **1**,

wherein the reference point is arranged on the opposite side to the imaging unit in the laminating direction of the first member and the second member which are laminated.

6. The method of manufacturing a liquid ejecting head according to claim **1**,

wherein the measuring of the distance between the reference point and the surface which extends from the bonding surface of the second member is performed using a non-contact type measuring unit.

7. The method of manufacturing a liquid ejecting head according to claim **6**,

wherein the measuring unit is a laser type range finder.

8. The method of manufacturing a liquid ejecting head according to claim **6**,

wherein the measuring unit and the imaging unit are positioned on the same side of the bonding surface.

9. The method of manufacturing a liquid ejecting head according to claim **6**,

wherein the measuring unit and the imaging unit are positioned on opposing sides of the bonding surface.

10. The method of manufacturing a liquid ejecting head according to claim **1**, further comprising:

confirming a state of the bonding surface, represented by the presence or absence of reflection of infrared rays, to determine whether the liquid ejecting head passes or fails manufacture.

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